THE EFFECT OF GLOBAL POPULATION GROWTH ON SUSTAINABLE DEVELOPMENT GOAL TARGETS 6.1 AND 6.2

by
Mackenzie Dalton Webber

A capstone submitted to Johns Hopkins University in conformity with the requirements for the degree of Master of Science in Environmental Sciences and Policy

Baltimore, Maryland
December 2020

Abstract

According to the United Nations Sustainable Development Goal (SDG) 6 Synthesis Report on Water and Sanitation, the world is not on track to achieve SDG targets 6.1 or 6.2, which aim to provide global access to water and sanitation services by 2030 (United Nations, 2018). To achieve SDG targets 6.1 and 6.2 as the global population continues to rise, it is important that an emphasis is placed on slowing population growth, improving international development, and increasing overall quality of life. While social scientists have long shown the link between increased development and reduced population growth, there has not been a direct link exhibited between slowing population growth and access to water and sanitation (Sinding, 2009). Therefore, this quantitative research aims to establish the connection between population growth and access to water and sanitation. It also analyzes trends at the urban and rural level to delve deeper into the population dynamics to improve access to WASH, measured by SDG 6.1 and 6.2 indicators. Using regional SDG progress and population growth rates, this research will demonstrate the impact of population growth on achieving SDG 6.1 and 6.2. Results indicate that if current rates continue and no intervention is made, population growth will make globally achieving SDG 6.1 and 6.2 impossible. Stabilizing the population has many benefits, such as reducing both resource use and environmental degradation and making SDG 6.1 and 6.2 more feasible. As climate change progresses and the population continues to rise, it is important to understand the connection between water and sanitation and population growth to find synergistic ways to improve both (Graff and Bremner, 2014). Additionally, it is necessary to consider population growth when determining prioritization for development efforts for the SDG 6.1 and 6.2 targets.

Capstone Advisor: Dr. Josh Newton (Independent Consultant)

Capstone Professor: Dr. Daniel Zachary

Acknowledgements

I would like to express my great appreciation to Dr. Josh Newton and Dr. Daniel Zachary for their support on my capstone project.

Dedication

This capstone is dedicated to Dr. Tyler Dickovick, former Professor of Politics and International Development from Washington and Lee University, whose inquisitive and thoughtful nature sparked my interest in International Development.

Table of Contents

List of Tables

List of Figures

Introduction

Overview

Globally, 2.2 billion people lack safely managed drinking water, 4.5 billion people lack sanitation services, and 3 billion people cannot wash their hands in their own home (United Nations, 2020). Additionally, the global population is expected to reach 8.5 billion by 2030 and 9.7 billion by 2050, a considerable jump from the 2020 population of 7.7 billion (United Nations, 2015; U.S. Census, 2020). Suppose the population growth rate is not outpaced by expanding access to water and sanitation. In that case, this rapid population growth will only further strain resources and reduce access to water and sanitation. This highlights the necessity to explore the relationship between access to water and sanitation and population growth.

Water and sanitation are human rights, so the United Nations has committed to achieving Sustainable Development Goal (SDG) targets 6.1 and 6.2 to ensure universal clean water and sanitation for all by 2030 (United Nations, 2016; United Nations, 2018). However, according to the 2018 SDG 6 Synthesis Report on Water and Sanitation, the world is not on track to achieve these targets. The current population growth trajectory makes it particularly difficult to accomplish, especially since most of the population growth is expected to come from nine countries, most of whom already have reduced access to sanitation and drinking water (United Nations, 2019). The countries are India, Nigeria, Pakistan, the Democratic Republic of the Congo, Ethiopia, Tanzania, the United States, Indonesia, and Uganda (United Nations, 2019). In the majority of these countries, only 50% of the population has basic sanitation services and less than 30% of the population has safe drinking water, meaning that the majority of the countries that will contribute most to the rising global population in the coming decades

are not well-positioned to achieve SDG 6.1 and 6.2 targets (United Nations, 2018). This combination of high population growth and the current lack of access to water, sanitation, and hygiene (WASH) makes achieving universal clean water and sanitation especially difficult, particularly for rural populations, which currently have less access to WASH (United Nations, 2018). This research aims to understand how population growth affects achieving SDG targets 6.1 and 6.2.

Definitions of SDG Targets and Indicators

The SDGs on WASH were created based on the Millennium Development Goals (MDGs) (WHO, 2018). The MDG on WASH set in 2000 was to "halve the proportion of people without sustainable access to safe drinking water and basic sanitation" by 2015 (WHO, 2018). This goal was met in 2018 for drinking water; however, access was not equitable across regions, geographic areas, or socioeconomic levels. Additionally, basic sanitation improvement rates were too slow to achieve the sanitation aspect of the MDG, especially in urban areas where population increased rapidly. After the 2015 MDGs, the much more ambitious SDGs were set to ensure universal access to sanitation and water services is achieved quickly.

SDG 6 includes several targets designed to ensure a holistic approach to improving global access to water and sanitation by 2030. Additionally, each target has numeric indicators used to track progress toward achieving the target (United Nations, 2018). In the SDG framework, there are targets and indicators that track global progress towards access to drinking water, sanitation, handwashing, and ending open defecation. These targets and indicators for SDG 6.1 and 6.2 are shown in Table 1.

Table 1: SDG 6.1 and 6.2 targets and indicators (United Nations, 2018)

Goal	Target	Indicator(s)
6.1	"By 2030, achieve universal and equitable access to safe and affordable drinking water for all"	**"6.1.1** Proportion of population using safely managed drinking water services"
6.2	"By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations"	**"6.2.1a** Proportion of population using safely managed sanitation services and proportion of population practicing open defecation" **"6.2.1b** Proportion of population with basic handwashing facilities on premises"

SDG indicator 6.1.1 defines safely managed drinking water services as "drinking water from an improved water source that is located on-premises, available when needed and free from faecal and priority chemical contamination" (United Nations, 2018). SDG indicator 6.2.1a defines safely managed sanitation services as the "use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated offsite"; the opposite practice is open defecation, which is defined as the "disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other open spaces or with solid waste" (United Nations, 2018). SDG indicator 6.2.1a measures populations with safely managed sanitation and those practicing open defecation because ending open defecation is an important step to achieving universal access to sanitation services. Lastly, 6.2.1b defines basic handwashing as "availability of a handwashing facility on premises with soap and water" (United Nations, 2018). For easy access to water, sanitation services, and handwashing facilities all facilities must be accessible on premises.

SDG 6.1 and 6.2 indicator data is gathered at the national level based on nationally representative data sources, typically from information collected in national statistics office interviews (WHO/UNICEF JMP, n.d.c.). Then, access to water, sanitation, and hygiene are

categorized based on the “ladder” approach, which organizes access to WASH into a tiered system based on set criteria. This categorization method helps facilitate global monitoring and comparisons of service levels between populations (WHO/UNICEF JMP, n.d.a). The drinking water, sanitation, and hygiene ladders are shown in Figures 1, 2, and 3. For SDG 6.1 and 6.2 the goal is for universal access to each ladder's top tier.

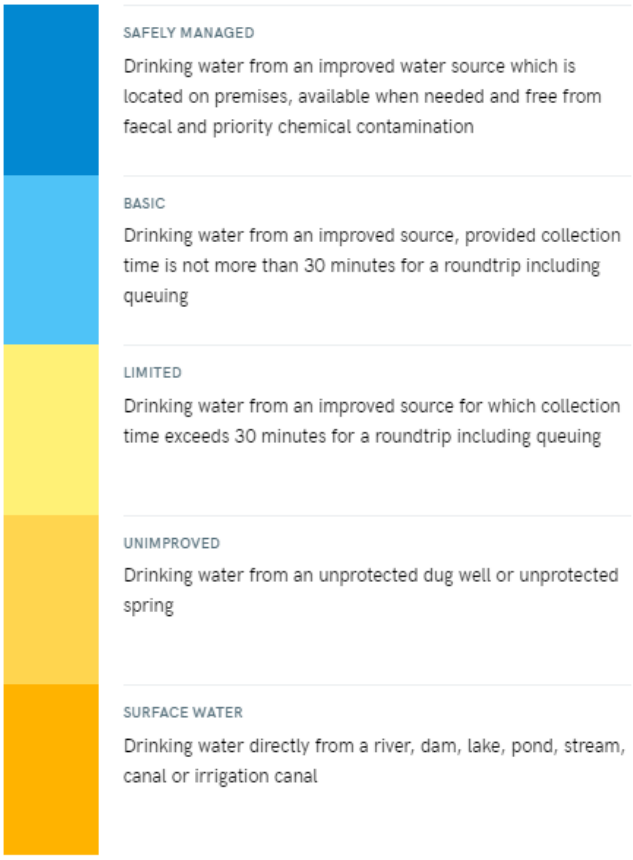

Figure 1: Drinking Water Ladder (WHO/UNICEF JMP, n.d.a)

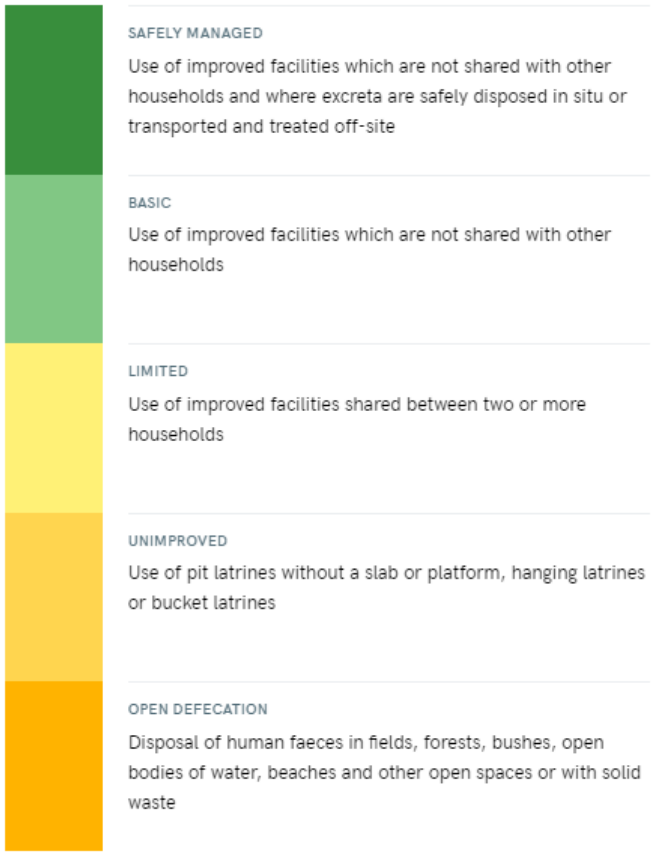

Figure 2: Sanitation Ladder (WHO/UNICEF JMP, n.d.d)

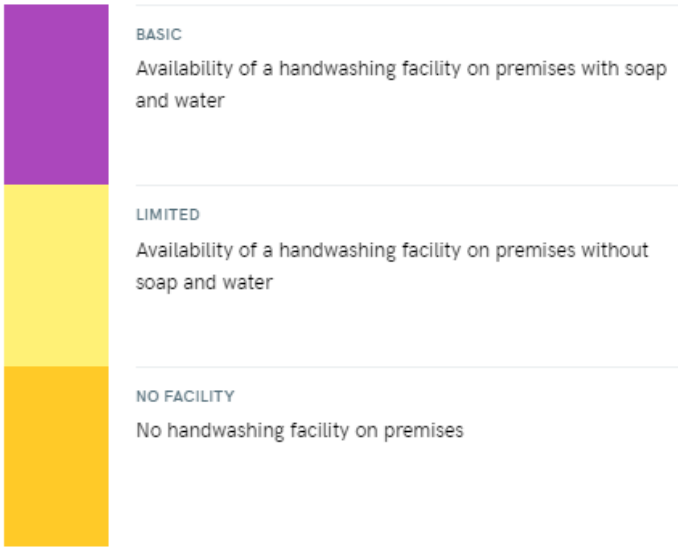

Figure 3: Hygiene Ladder (WHO/UNICEF JMP, n.d.b)

Research Methodology

Overview

This project analyzes the regional current and projected progress of SDG targets 6.1 and 6.2 in the context of population growth with a specific focus on developing nations. The project uses available data on each SDG 6.1 and 6.2 indicator and population growth to identify trends at the regional level and compare progress toward each indicator to regional population growth. This comparison seeks to identify regions where population growth exceeds access to WASH, as measured by each SDG 6.1 and 6.2 indicator growth rate. These regions are particularly important to focus international development efforts because if current rates continue and no intervention is made, they will never achieve universal access to WASH. The research methodology is shown in Figure 4.

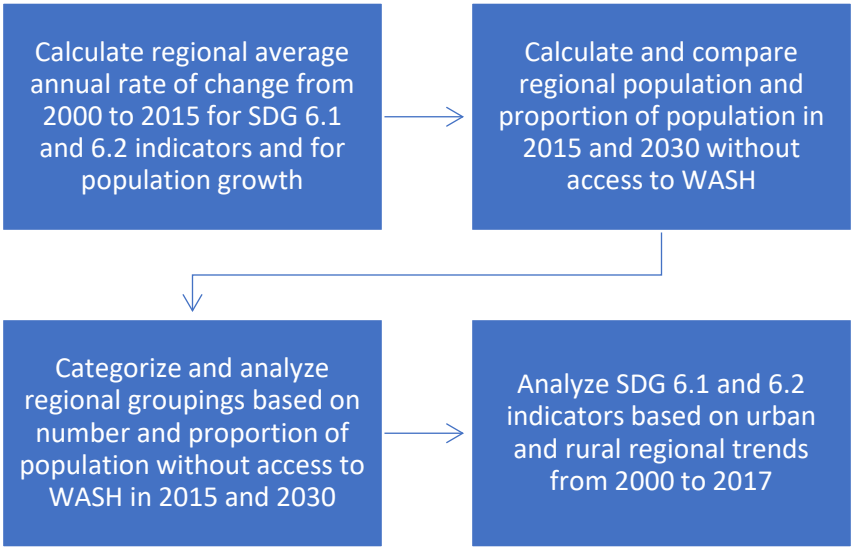

Figure 4: Research Methodology.

Note that "access to WASH" refers to populations with access to drinking water (6.1), access to sanitation services (6.2), access to handwashing facilities (6.2), and who do not practice open defecation (6.2). Additionally, "aspect of WASH" is the generic term used herein to refer to any of the four indicator subjects: drinking water, sanitation services, handwashing facilities, and absence of open defecation. The ultimate goal of SDG 6.1 and 6.2 is to achieve universal access to WASH (United Nations, 2018).

SDG 6.1 and 6.2 Indicators and Population Data

Regional SDG 6.1 and 6.2 indicator data, which is available on the United Nations' SDG Indicators Database, was analyzed to identify trends in access to WASH (United Nations, 2020). Population growth rates and estimates were gathered from the United Nations' World Population Prospects (United Nations, 2019). Note that yearly SDG 6.1 and 6.2 indicator data is available from 2000 to 2017 and population growth is reported every five years from 2000 to 2020. To ensure data is consistent between the two metrics, 2000 to 2015 data was used in this analysis where population growth rates and SDG 6.1 and 6.2 indicators were directly compared.

Rural vs. urban distinctions and regional groupings were determined according to the United Nations' standard geographic codes available online at the United Nations Statistics Division (United Nations, n.d.). Analysis was carried out at the regional level due to lack of reporting in some countries; analyzing regionally allowed for a robust dataset while still being granular enough to enable targeted analyses. Some regions did not have adequate data to report at the regional level as well, which is indicated in Tables 4-8.

Note that for most of the SDG indicators the goal is to have the population reach 100% (e.g., population using safely managed drinking water) while for other SDG indicators the goal is to reach 0% (e.g., population practicing open defecation). Therefore, the calculations of these SDG indicators differs to account for the different goals.

SDG 6.1 and 6.2 Indicators Compared to Population Growth

This analysis was only completed for developing countries as developed countries either are very close or have already achieved universal access to WASH. This research focuses on the regions that are not on track to achieve universal access to all aspects of WASH by 2030.

For each SDG 6.1 and 6.2 indicator and each year from 2000 to 2015, the number of individuals with access to WASH was calculated using the proportion of the population with access to that given aspect (measured by SDG 6.1 and 6.2 indicators) and the total regional population (United Nations, 2020; United Nations, 2019). Then, for each aspect of WASH, the rate of change was identified for each year from 2000 to 2015 and averaged together. Some regions did not have complete reporting data starting from 2000, so the annual average rate of change was calculated using the available data starting with the first available year and ending with 2015. Additionally, average annual rate of population change by region is reported every

five years by the United Nations Population Division (United Nations, 2019). Using this data, the regional average annual rate of population change was calculated from 2000 to 2015.

This analysis assumes that regional average population growth and SDG 6.1 and 6.2 indicator growth from 2000 to 2015 are representative of 2015 to 2030 growth for that region as well. Given the 2015 total population per region and population with access to each aspect of WASH per region, two predictive calculations were made. First, using the 2015 total population per region and average annual total population growth, the predicted 2030 total regional population was calculated using a continuously compounding population growth formula. The same process was repeated using the subset of the population with access to each aspect of WASH and the WASH access growth rate for that aspect to find the predicted number of individuals with access to each aspect of WASH in 2030. The predicted population with access to WASH was then subtracted from the total predicted population to find the number of individuals without access to each aspect of WASH in 2030. These numbers were then compared to the previously estimated 2015 numbers of individuals without access to each aspect of WASH. Alongside the number of individuals, the proportion of the total population without access to WASH in 2030 was calculated and compared to the reported 2015 proportion without access to WASH.

Regional Level of Concern Categorizations

Using the predictions on both number of individuals and proportion of population without access to WASH in 2015 and 2030, regions were sorted into four levels of concern (Table 2). Regions were sorted into these groups for each aspect of WASH individually to identify specific areas where improvements need to be made to achieve SDG 6.1 and 6.2

targets. Therefore, for example, Central America could be in the Medium concern category for access to drinking water and the Very Low concern category for access to sanitation facilities.

Table 2: Level of concern based on access to WASH and population growth if current rates continue.

Level of Concern	Description	Measurement	Implications
High	Proportion of population and number of people without access to WASH rising over time	Proportion of population without access to WASH 2030 > Proportion of population without access to WASH 2015 *and* Number of people without access to WASH 2030 > Number of people without access to WASH 2015	Will never achieve universal access to WASH
Medium	Proportion of population without access to WASH decreasing, *but* number of people without access increasing	Proportion of population without access to WASH 2030 < Proportion of population without access to WASH 2015 *but* Number of people without access to WASH 2030 > Number of people without access to WASH 2015	Will very slowly achieve near universal access to WASH (asymptotically trends towards universal)
Low	Proportion of population *and* number of people without access to WASH decreasing, *but* not at a fast enough rate to achieve access by 2030	Proportion of population without access to WASH 2030 < Proportion of population without access to WASH 2015 *and* Number of people without access to WASH 2030 < Number of people without access to WASH 2015 *but* Number of people without access to WASH in 2030 ≠ 0	Achieve universal access to aspect of WASH after 2030 (timing varies)
Very Low	Proportion and number of people without access to WASH in 2030 is 0	Proportion of population without access to WASH 2030 = 0 *and* Number of people without access to WASH 2030 = 0	Achieve universal access to aspect of WASH by 2030

The Medium concern category represents regions where the proportion of the population without and number of people without access to WASH can change in opposite

directions. This is possible due to rapid population growth, where the number of people in the population shifts so dramatically such that the proportion without access goes down while the overall number of without access individuals goes up. See the fictional example, which indicates how number of people and proportion of the population do not always increase or decrease together; instead, due to underlying population growth of the total population, these can diverge (Table 3). To get a full picture of the data, it is important to measure both of these metrics when taking into account population growth.

Table 3: Fictional example of population and access to WASH growth

Metric	Year 1	Year 2	Description of Change
Total Population (50% growth rate)	100	150	Number of people in total population grows
Access to WASH Population (60% growth rate)	50	80	Number of people with access to WASH increases
Without Access to WASH Population	50	70	Number of people without access to WASH increases
Proportion of Population Without Access to WASH	50%	46.7%	Proportion of population without access to WASH decreases

Rural vs. Urban Access to WASH

Additionally, after analyzing at the regional level, the dynamics within individual populations for SDG target 6.1 and 6.2 indicators were analyzed at the rural vs. urban level to identify trends of population demographics and access to WASH across the world. This is important to analyze separately because rural vs. urban access to WASH grows at dramatically differing rates and requires different development planning efforts. The rural vs. urban SDG 6.1 and 6.2 indicator data was not compared to population growth data like the SDG 6.1 and 6.2 indicator rates were, allowing the full available data set from 2000 to 2017 to be used.

Results

SDG 6.1 and 6.2 Indicators Compared to Population

Comparing population growth rate to SDG 6.1 and 6.2 indicator rate of change indicates that for most regions, access to WASH exceeds the population growth rate (Table 4). Note that total population growth represents the rate that the total population grows; however, the growth rates of SDG 6.1 and 6.2 indicators show the rate that the population that has access to WASH grows. These growth rates cannot be directly compared due to different underlying populations. Also, since the ultimate goal for proportion of the population practicing open defecation is 0%, a negative growth rate is considered progress toward achieving SDG 6.2. Also, not all regions and indicator rates of change are shown due to inadequate reporting data at the regional level.

Table 4: 2000 to 2015 Average annual rate of change for population growth and access to WASH, measured by SDG 6.1 and 6.2 Indicators. Dashes indicate no available data.

Region	2000 to 2015 Average Annual Rate of Change (%)				
	Total Population Growth	Population with Access to Drinking Water Growth (6.1.1)	Population Practicing Open Defecation Growth (6.2.1a)	Population with Access to Sanitation Facilities Growth (6.2.1a)	Population with Access to Handwashing Facilities Growth (6.2.1b)
Central America	1.48%	2.10%	-7.43%	9.47%	1.42%
Central Asia	1.42%	3.04%	-17.10%	-	2.02%
Eastern Africa	2.77%	7.09%	-1.08%	-	4.62%
Eastern Asia	0.53%	-	-9.19%	5.40%	-
Landlocked Developing Countries (LLDCs)	2.33%	4.21%	-1.44%		3.72%
Latin America and the Caribbean	1.19%	3.24%	-6.06%	7.43%	-
Least Developed Countries (LDCs)	2.39%	4.42%	-1.31%	-	2.53%
Middle Africa	3.15%	-	2.28%	-	12.58%
Northern Africa	1.78%	-	-4.13%	5.18%	0.51%
Oceania	1.58%	-	2.39%	2.45%	-

Region	2000 to 2015 Average Annual Rate of Change (%)				
	Total Population Growth	Population with Access to Drinking Water Growth (6.1.1)	Population Practicing Open Defecation Growth (6.2.1a)	Population with Access to Sanitation Facilities Growth (6.2.1a)	Population with Access to Handwashing Facilities Growth (6.2.1b)
Small Island Developing States (SIDS)	1.19%	-	-1.15%	-	1.37%
South America	1.12%	1.46%	-6.05%	6.90%	-
South-Eastern Asia	1.26%	-	-4.73%	-	2.09%
Southern Africa	1.35%	-	-5.25%	-	1.87%
Southern Asia	1.51%	3.92%	-4.37%	-	1.45%
Sub-Saharan Africa	2.70%	5.24%	0.01%	4.08%	5.54%
Western Africa	2.70%	4.68%	0.92%	3.65%	3.31%
Western Asia	2.22%	3.08%	-1.35%	3.77%	-

Analyzing the total population and population without access to each aspect of WASH (measured by SDG 6.1 and 6.2 indicators) for 2015 and 2030 shows that the majority of analyzed regions and aspects of WASH are not predicted to achieve universal access by 2030 if current rates continue (Table 5). Four regions for four individual aspects of WASH do achieve universal access by 2030; these are shown in green. No region shown achieves universal access to every aspect of WASH by 2030. Note that these numbers cannot be added to identify a total number of individuals without access to WASH as some of these regions are not mutually exclusive. However, it is still important to analyze these metrics at multiple regional levels to identify widespread and small-scale trends.

Table 5: 2015 Population compared to 2030 population (thousands). Green indicates where universal access is predicted to be achieved. Dashes indicate no available data. Decimal places shown where necessary to make comparisons between the two datasets.

Regions	2015 Population (estimated; thousands)					2030 Population (predicted; thousands)				
	Total	Without Access to Drinking Water (6.1.1)	Practicing Open Defecation (6.2.1a)	Without Access to Sanitation Facilities (6.2.1a)	Without Access to Handwashing Facilities (6.2.1b)	Total	Without Access to Drinking Water (6.1.1)	Practicing Open Defecation (6.2.1a)	Without Access to Sanitation Facilities (6.2.1a)	Without Access to Handwashing Facilities (6.2.1b)
Central America	168,949	90,616	4,608	115,023	23,027	210,931	103,641	1,512	0	30,507
Central Asia	68,480	21,159	6	-	5,809	84,726	10,036	0.4	-	0
Eastern Africa	389,671	314,562	84,691	-	306,641	590,002	372,452	72,066	-	424,087
Eastern Asia	1,645,184	-	8,486	599,543	-	1,780,861	-	2,138	0	-
Landlocked Developing Countries (LLDCs)	473,817	314,228	98,890	-	309,313	672,262	372,187	79,680	-	384,949
Latin America and the Caribbean	623,934	162,098	19,894	447,906	-	746,005	0	8,016	209,634	-
Least Developed Countries (LDCs)	941,131	625,993	189,564	-	677,075	1,347,638	736,052	155,699	-	961,495
Middle Africa	154,203	-	28,322	-	138,558	247,384	-	39,859	-	144,095
Northern Africa	223,862	-	13,179	162,371	58,854	292,499	-	7,093	158,726	114,412
Oceania	39,859	-	1,531	19,138	-	50,553	-	2,193	20,638	-
Small Island Developing States (SIDS)	68,856	-	5,187	-	32,016	82,290	-	4,367	-	37,027
South America	412,363	85,172	12,612	294,729	-	488,062	81,023	5,089	156,902	-
South-Eastern Asia	634,306	-	53,597	-	163,266	766,373	-	26,382	-	122,371
Southern Africa	62,985	-	3,591	-	36,604	77,114	-	1,634	-	42,166
Southern Asia	1,827,847	782,520	449,202	-	787,723	2,293,717	411,309	233,073	-	1,000,290

Regions	2015 Population (estimated; thousands)					2030 Population (predicted; thousands)				
	Total	Without Access to Drinking Water (6.1.1)	Practicing Open Defecation (6.2.1a)	Without Access to Sanitation Facilities (6.2.1a)	Without Access to Handwashing Facilities (6.2.1b)	Total	Without Access to Drinking Water (6.1.1)	Practicing Open Defecation (6.2.1a)	Without Access to Sanitation Facilities (6.2.1a)	Without Access to Handwashing Facilities (6.2.1b)
Sub-Saharan Africa	958,577	714,621	208,064	785,692	716,792	1,436,512	901,505	208,380	1,117,549	881,172
Western Africa	351,718	271,036	91,473	284,799	234,820	526,974	364,213	105,076	411,364	335,006
Western Asia	257,658	64,304	5,910	141,279	-	359,697	52,994	4,825	154,700	-

Table 6 indicates the number of additional people per region who are predicted to not have access to each aspect of WASH in 2030 relative to 2015. Regions where rates of WASH access is increasing is shown with "No additional" as no additional individuals are predicted to lack access to WASH by 2030 compared to 2015. However, not all of the regions with "No additional" are predicted to necessarily achieve universal access to WASH by 2030; the same four regions indicated in Table 5 that are predicted to reach universal access to that aspect of WASH by 2030 are shown in green. Table 6 shows that several regions for aspects of WASH are expected to have additional individuals without access to WASH by 2030.

Table 6: Number of additional people who are predicted to not have access to WASH in 2030 relative to 2015 (thousands). Green indicates where universal access is predicted to be achieved. Dashes indicate no available data.

Region	Number of Additional People Who Will Not Have Access to WASH from in 2030 Relative to 2015 (predicted; thousands)			
	Without Access to Drinking Water (6.1.1)	Practicing Open Defecation (6.2.1a)	Without Access to Sanitation Facilities (6.2.1a)	Without Access to Handwashing Facilities (6.2.1b)
Central America	13,026	No additional	No additional	7,480
Central Asia	No additional	No additional	-	No additional
Eastern Africa	57,890	No additional	-	117,447
Eastern Asia	-	No additional	No additional	-
Landlocked Developing Countries (LLDCs)	57,959	No additional	-	75,636
Latin America and the Caribbean	No additional	No additional	No additional	-
Least Developed Countries (LDCs)	110,059	No additional	-	284,421
Middle Africa	-	11,537	-	5,537
Northern Africa	-	No additional	No additional	55,558
Oceania	-	662	1,501	No additional
Small Island Developing States (SIDS)	-	No additional	-	5,012
South America		No additional	No additional	No additional
South-Eastern Asia	-	No additional	-	No additional
Southern Africa	-	No additional	-	5,563
Southern Asia	No additional	No additional	-	212,567
Sub-Saharan Africa	186,884	316	331,858	164,380
Western Africa	93,177	13,602	126,565	100,186

Region	Number of Additional People Who Will Not Have Access to WASH from in 2030 Relative to 2015 (predicted; thousands)			
	Without Access to Drinking Water (6.1.1)	**Practicing Open Defecation (6.2.1a)**	**Without Access to Sanitation Facilities (6.2.1a)**	**Without Access to Handwashing Facilities (6.2.1b)**
Western Asia	No additional	No additional	13,420	-

It is important to not only consider the number of people without access to WASH, but to also analyze the shifts in the proportion of the population without access to WASH. Therefore, Table 7 shows the proportion of the population without access to WASH for 2015 and 2030. Several regions, indicated in green, show a proportion less than or equal to 0%, indicating they are predicted to achieve universal access by 2030. Red indicates regions where the proportion of the population without access to WASH is predicted to increase from 2015 to 2030.

Table 7: 2015 and 2030 Proportion of population without access to WASH. Green indicates regions where universal access is predicted to be achieved by 2030. Red indicates regions where the proportion of the total population without access is increasing over time. Dashes indicate no available data.

** The dramatic increase in predicted proportion of population for Northern Africa without access to handwashing facilities is due to an abnormality in the United Nations reporting data in 2009, which reported an 11% decrease in handwashing that year, despite all other years reporting incremental increases in handwashing of 1% or less per annum (United Nations, 2020). Because predictions are made using growth averaged across all years, this one year of dramatic decline in Northern Africa caused the access predicted in 2030 to decrease relative to 2015.*

Region	2015 Proportion of Total Population (estimated)				2030 Proportion of Total Population (predicted)			
	Without Access to Drinking Water (6.1.1)	Practicing Open Defecation (6.2.1a)	Without Access to Sanitation Facilities (6.2.1a)	Without Access to Handwashing Facilities (6.2.1b)	Without Access to Drinking Water (6.1.1)	Practicing Open Defecation (6.2.1a)	Without Access to Sanitation Facilities (6.2.1a)	Without Access to Handwashing Facilities (6.2.1b)
Central America	53.63%	2.73%	68.08%	13.63%	49.14%	0.72%	-5.77%	14.46%
Central Asia	30.90%	0.01%	-	8.48%	11.85%	0.0005%	-	-0.16%
Eastern Africa	80.72%	21.73%	-	78.69%	63.13%	12.21%	-	71.88%
Eastern Asia	-	0.52%	36.44%	-	-	0.12%	-32.04%	-
Landlocked developing countries (LLDCs)	66.32%	20.87%	-	65.28%	55.36%	11.85%	-	57.26%
Latin America and the Caribbean	25.98%	3.19%	71.79%	-	-0.68%	1.07%	28.10%	-
Least Developed Countries (LDCs)	66.51%	20.14%	-	71.94%	54.62%	11.55%	-	71.35%
Middle Africa	-	18.37%	-	89.85%	-	16.11%	-	58.25%
Northern Africa	-	5.89%	72.53%	26.29%	-	2.42%	54.27%	39.12%*
Oceania	-	3.84%	48.01%	-	-	4.34%	40.83%	-
Small island developing States (SIDS)	-	7.53%	-	46.50%	-	5.31%	-	45.00%
South America	20.65%	3.06%	71.47%	-	16.60%	1.04%	32.15%	-
South-Eastern Asia	-	8.45%	-	25.74%	-	3.44%	-	15.97%
Southern Africa	-	5.70%	-	58.11%	-	2.12%	-	54.68%
Southern Asia	42.81%	24.58%	-	43.10%	17.93%	10.16%	-	43.61%
Sub-Saharan Africa	74.55%	21.71%	81.96%	74.78%	62.76%	14.51%	77.80%	61.34%

Region	2015 Proportion of Total Population (estimated)				2030 Proportion of Total Population (predicted)			
	Without Access to Drinking Water (6.1.1)	Practicing Open Defecation (6.2.1a)	Without Access to Sanitation Facilities (6.2.1a)	Without Access to Handwashing Facilities (6.2.1b)	Without Access to Drinking Water (6.1.1)	Practicing Open Defecation (6.2.1a)	Without Access to Sanitation Facilities (6.2.1a)	Without Access to Handwashing Facilities (6.2.1b)
Western Africa	77.06%	26.01%	80.97%	66.76%	69.11%	19.94%	78.06%	63.57%
Western Asia	24.96%	2.29%	54.83%	-	14.73%	1.34%	43.01%	-

Lastly, by analyzing the both the predicted number of individuals and proportion of population without WASH in 2030, regional categorization were established and are shown in Table 8. Refer to Table 2 for a full description of the levels of concern. A total of four regions are in the High category, which includes Central America, Northern Africa, and Southern Asia for access to handwashing facilities and Oceania for practicing open defecation. The majority of regions are in the Medium or Low category, with four regions in the Very Low category.

Table 8: Levels of concern based on predicted proportion of population and number of individuals without access to WASH in 2030 for each region. Refer to Table 2 for descriptions of High, Medium, Low and Very Low levels of concern. Dashes indicate no available data.

Region	**Drinking Water (6.1.1)**	**Open Defecation (6.2.1a)**	**Sanitation Facilities (6.2.1a)**	**Handwashing Facilities (6.2.1b)**
Central America	Medium	Low	Very Low	High
Central Asia	Low	Low	-	Very Low
Eastern Africa	Medium	Low	-	Medium
Eastern Asia	-	Low	Very Low	-
Landlocked Developing Countries (LLDCs)	Medium	Low	-	Medium
Latin America and the Caribbean	Very Low	Low	Low	-
Least Developed Countries (LDCs)	Medium	Low	-	Medium
Middle Africa	-	Medium	-	Medium
Northern Africa	-	Low	Low	High
Oceania	-	High	Medium	-
Small Island Developing States (SIDS)	-	Low	-	Medium
South America	Low	Low	Low	-
South-Eastern Asia	-	Low	-	Low
Southern Africa	-	Low	-	Medium
Southern Asia	Low	Low	-	High
Sub-Saharan Africa	Medium	Medium	Medium	Medium
Western Africa	Medium	Medium	Medium	Medium
Western Asia	Low	Low	Medium	-

Rural vs. Urban Population Access to WASH

Figures 5 through 7 show world averages for SDG 6.1 and 6.2 indicators based on rural vs. urban populations from 2000 to 2017. Figure 8 shows the proportion of the population with access to handwashing facilities by geographic area from 2012 to 2017; due to lack of reliable global and urban data regarding access to handwashing facilities, the United Nations only reports world averages from 2012 to 2017 for all global area and rural area. Note these calculations cannot be directly compared to the comparisons between population growth and access to WASH shown in Tables 4 to 8, as these datasets analyze different years and contain both developed and developing nation data. However, it is still useful for identifying overall trends at the urban and rural levels.

According to SDG 6.1 and 6.2 indicators, urban populations have higher proportions of access to each aspect of WASH. However, the rate of SDG 6.1 and 6.2 indicator growth is greater for many rural populations compared to urban. As seen in Figure 6, substantial growth has been seen in rural populations for 6.2.1a, which tracks access to sanitation services, as the levels are nearing urban levels.

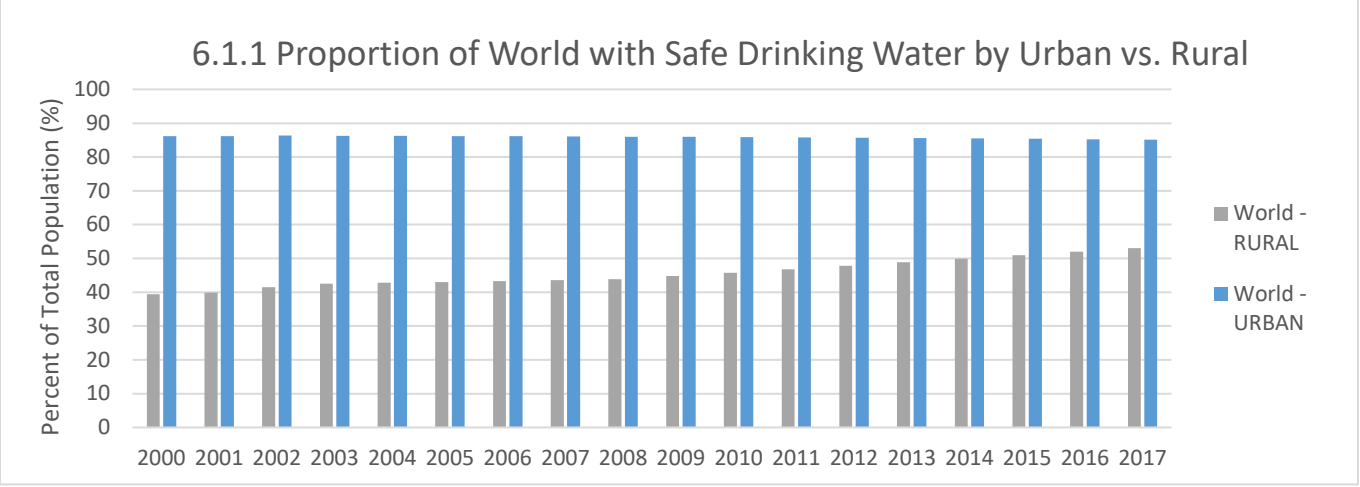

Figure 5: 6.1.1 Proportion of World Using Safely Managed Drinking Water by Urban vs. Rural (%)

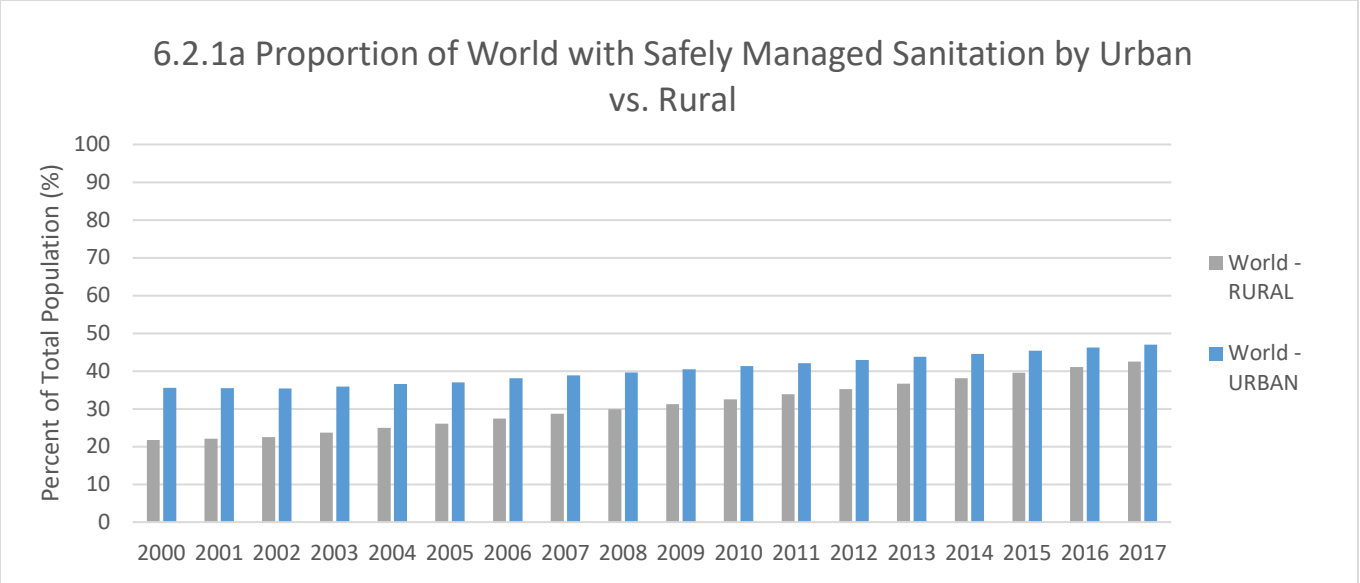

Figure 6: 6.2.1a Proportion of Population Using Safely Managed Sanitation Services by Urban vs. Rural (%)

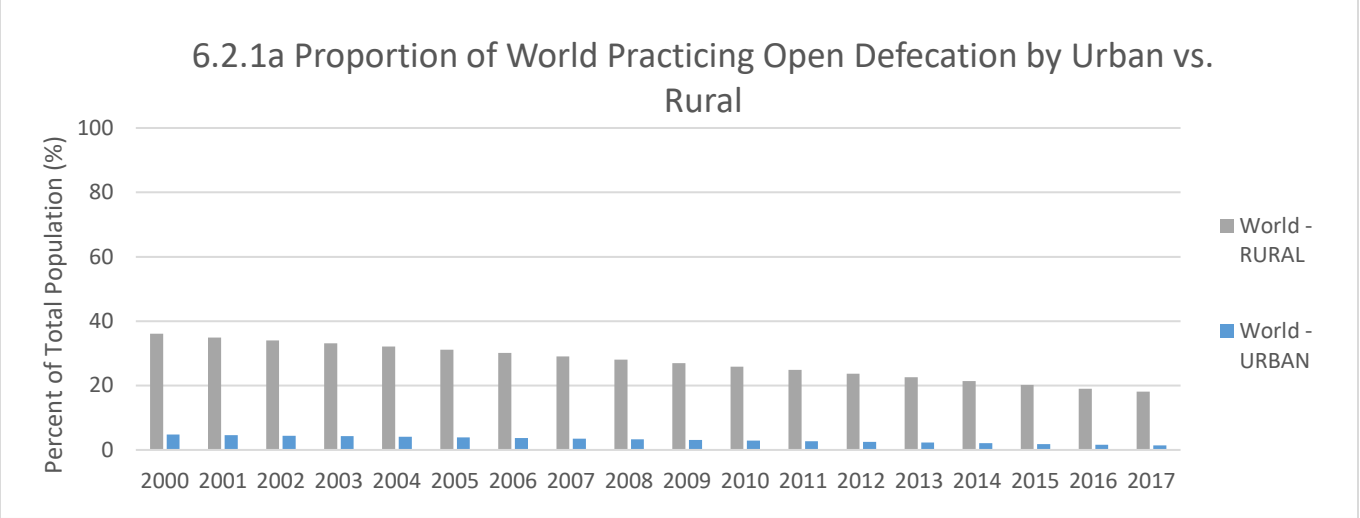

Figure 7: 6.2.1a Proportion of World Practicing Open Defecation by Urban vs. Rural (%)

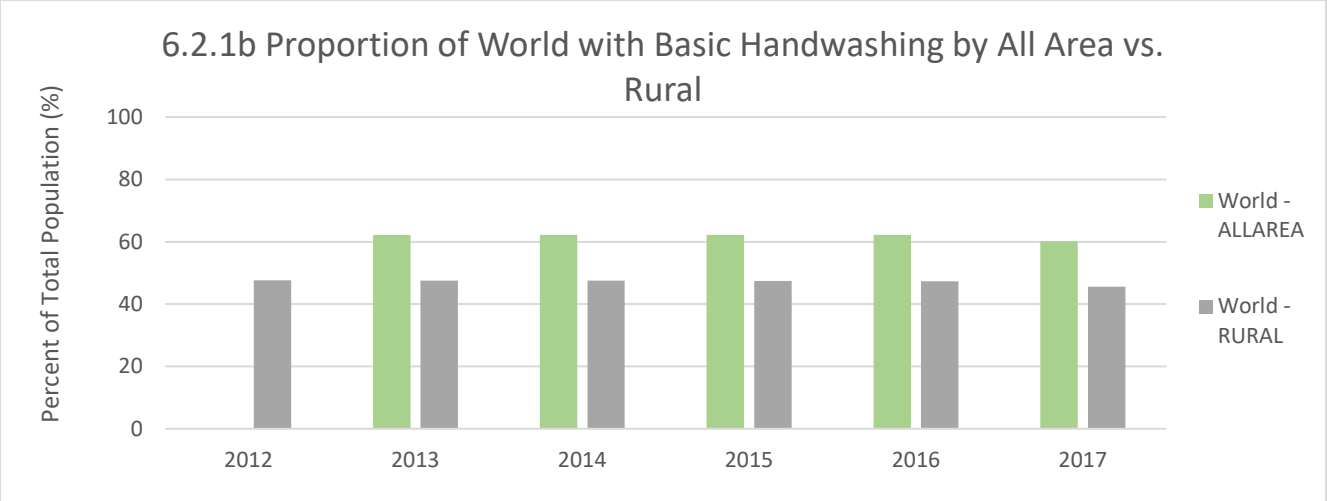

Figure 8: 6.2.1b Proportion of Population with Basic Handwashing Facilities by All Area vs. Rural (%)

Discussion

SDG 6.1 and 6.2 Indicators Compared to Population Growth

While ongoing progress toward achieving SDG 6.1 and 6.2 targets is promising, it is important to not only consider the growth of SDG 6.1 and 6.2 indicators in isolation, but also to contextualize this growth with population growth. For example, it is beneficial if a given region is making forward progress in access to WASH based on the proportion of their population, but if that same region is experiencing rapid population growth such that the number of individuals without WASH access is also increasing, then there is cause to reframe that region as one in need of additional aid. Looking only at proportional growth of access to WASH doesn't give the full picture; it is important that progress is viewed in the context of population growth to gain a fuller understanding of which regions are most in need of aid. This research analyzes four levels of concern for access to WASH in relation to population growth (Table 2).

High Concern

Of the 18 regions analyzed for each of the four aspects of WASH, there were four regions in the High concern category. If the 2000 to 2015 population and access to WASH average growth rates continue, the regions in the High concern category will never achieve access to the given aspect of WASH. In these regions for these aspects of WASH, population growth is outpacing the expansion of access to WASH. Due to high population growth, the proportion of the population practicing open defecation in Oceania has increased since 2000, despite the ultimate goal being negative growth for open defecation (WHO/UNICEF JMP, n.d.c). While many of the other regions in the High category barely see the proportion of their population without access to WASH increasing, Oceania is experiencing a relatively rapid increase in the proportion of people practicing open defecation, with an average increase of 2.39% a year (Table 4). Additionally, this growing proportion that practices open defecation is only exacerbated by the simultaneously growing total population, which grows at a rate of 1.58% annually (Table 4). This combination of increased open defecation proportion and a growing population makes reversing this trend difficult.

Like greater Oceania, Papua New Guinea, a nation in the Southwestern Pacific Ocean, has seen an increase in the proportion of the population practicing open defecation from 2000 to 2015. While an increase in open defecation is a complex problem stemming from multiple factors, ranging from a lack of education regarding sanitation practices to poor upkeep of sanitation facilities, limiting population growth through family planning is another viable method Papua New Guinea can use to improve access to WASH (OCHA Services, 2014). Women in Papua New Guinea have limited access to modern birth control with only 21.7% of

women in 2019 using modern birth control; this is compared to the Southeast Asia and Oceania regional average of 39% in 2019 (Family Planning, 2020). Additionally, 32% of married women still have unmet contraceptive needs (Family Planning, 2020). Unmet need refers to "the percentage of fecund women of reproductive age who want no more children or to postpone having the next child, but are not using a contraceptive method, plus women who are currently using a traditional method of family planning" (Family Planning, 2020). While the direct positive effects of access to family planning and birth control are well known, such as spacing pregnancies, reducing poverty, and improving the health of mother and child, expanding access to family planning also has longer ranging implications into WASH due to its direct impact on population growth (Graff and Bremner, 2014). Directly investing in family planning is a synergistic way to meet women's unmet needs while also improving access to WASH (Graff and Bremner, 2014). Oceania as a whole is predicted to have 662,000 more people practicing open defecation in 2030 compared to 2015 (Table 6). It is of utmost importance to work to reduce population growth as a means of increasing access to WASH in these regions that aren't predicted to ever achieve universal access.

Medium Concern

There were six regions in the Medium concern category for two or more aspects of WASH and five regions for only one aspect of WASH. If 2000 to 2015 average population and access to WASH growth rates continue, regions in this concern level will see the proportion of population without access to WASH decrease, but the number of individuals without access increase. This is due to the underlying total population increasing dramatically enough such that both the number of those with and without access to WASH increases. For example,

Eastern Africa, which falls in the Medium category for access to safely managed drinking water, has a high annual average growth rate in access to clean water at 7.09% and an average total population growth of 2.77% from 2000 to 2015 (Table 4). Although these two metrics cannot be compared directly due to the different populations that these rates represent, it demonstrates how regions with rapidly growing access to WASH can still have difficulty achieving universal access. If current rates continue, despite the high growth rate in access to clean water, Eastern African will still not achieve universal access by 2030 and the number of individuals without access will continue to rise. This is partly because of the high population growth rate and the massive discrepancy between the starting total population and the starting population with access, meaning that a dramatically more rapid WASH access growth rate is necessary to overcome the total population growth. Looking specifically at Kenya, Kenya's Sustainable Development Report notes that "the renewable fresh water per capita stands at 647 cubic meters [in 2012] and is projected to fall to 235 cubic meters by 2025 if supply does not keep up with population increase" (United Nations DESA, 2012). This predicted decline in available freshwater per capita does not even address the additional purification and filtration steps needed to provide clean drinking water, indicating that it will be even more difficult to provide clean drinking water with limited freshwater per capita. For an already water scarce country with high population growth it is difficult to provide clean safe drinking water.

However, stabilizing the population through access to family planning and birth control is an additional opportunity to improve overall community health and decrease strains of fresh water sources (Graff and Bremner, 2014). Note that population growth is not the sole cause of this lack of available freshwater; other draws include agricultural, commercial, and industrial

uses of water. Utilizing multiple methods in unison to improve access to WASH, such as building wells and educating communities on the importance of using clean sources of water as well as stabilizing population, are most likely to make a positive impact (Graff and Bremner, 2014). Since these regions are not on track to reach universal access to at least one aspect of WASH by 2030, it is imperative to utilize multiple methods to improve access to WASH (Table 7).

Low Concern

For the Low concern level, there were seven regions in the Low category for two or more aspects of WASH and seven more regions for only one aspect of WASH. If 2000 to 2015 average population and access to WASH growth rates continue, both the proportion and number of people without access to WASH will decrease. However, this increase in access to WASH will not be fast enough to achieve universal access by 2030.

There can be several factors causing this delayed access to WASH, such as too high population growth, too slow access to WASH growth, or a combination of both. If current rates change, population growth slows, or access to WASH growth increases, these regions can potentially achieve universal access by 2030. For example, South America in 2030 is expected to still have 32% of its population without access to sanitation services, which is about 15 million individuals (Table 5). The year over year expansion of access to sanitation services is promising, as it is expanding at a rate such that every year less South Americans are without access than the previous year, but it is still progressing far too slowly to achieve universal access by the United Nations goal of 2030 (Table 4). Analyzing Bolivia specifically, 60% of the rural population has access to sanitation services and the rural population as a whole has a 1% population growth rate (UNICEF, 2018). Due to this, it is predicted that rural Bolivia will reach universal

access to sanitation services around 2060, 30 years after the SDG 6.2 goal (UNICEF, 2018). Bolivia's current plan to address this gap in access to sanitation services is the construction of thousands of toilets per year. However, additionally slowing population growth could accelerate this progress to get closer to the 2030 goal. For example, Bolivia still has 36.6% of married women with unmet contraceptive needs, demonstrating a large gap to fill women's needs (Family Planning, 2020). This is an opportunity for Bolivia to meet women's unmet contraceptive needs, and in doing so to stabilize the population and improve access to WASH (Graff and Bremner, 2014).

Very Low Concern

Lastly, there are four developing regions that will achieve universal access to WASH by 2030 if 2000 to 2015 population and access to WASH growth rates continue. It is important to note that many developed regions not included in this analysis are also in this category as they have already achieved or are on track to achieve universal access in each aspect of WASH by 2030.

Urban vs. Rural Population Access to WASH

Additionally, after analyzing regional population growth and access to WASH, it is important to understand the differences within regions by urban and rural population. Figures 5 to 8 demonstrate that rural populations on average have smaller proportions of the population with access to WASH compared to urban populations. This is because urban populations have a higher density of people and therefore a single development project for a community (e.g., building a drinking water well) can have an impact on more people. This is compared to rural communities, which are less dense and therefore require more development projects to impact

the same number of people. For example, in Kenya and Uganda the mean number of people that use a common toilet is 10 in urban areas compared to 7 in rural areas (Tumwine et al., 2003). Toilets in urban areas typically have a higher number of people impacted, leading to a greater reduction in the rates of open defecation as well as improved overall sanitation. Additionally, in many urban places there is existing infrastructure making water and wastewater transportation easier compared to rural areas where water and wastewater infrastructure is minimal (UNESCO, 2015).

There is still much development needed for rural populations as they are below urban in achieving access to WASH and typically have higher fertility rates which can exacerbate the issue (CDC, 2018). Due to poor planning and higher fertility rates, there has been degraded water and sanitation for rural communities across the globe (Barnes et al., 2014). Also, urban populations are more likely to be educated than rural populations (Zhang et al., 2015). It has been shown that in houses where the head of the family is an educated person, toilets are less likely to be fouled due to the increased resources that educated families are likely to have (Tumwine et al., 2003). Access to water and sanitation lead to decreased health issues, such as diarrheal diseases, increasing the ability to get a job or education (World Bank, 2013). This in turn increases one's economic status, and therefore, typically leads to lower birth rates (World Bank, 2013). This reinforces the cyclical relationship between development, sanitation, and population growth by showing that educated households typically have more resources to maintain higher degrees of sanitation and have lower fertility rates. Increased funding and careful planning should be utilized for rural water and sanitation development to improve health, reduce population growth, and increase quality of life.

In addition to these quality of life improvements, investing in rural water and sanitation development is a financially beneficial undertaking. In rural areas of Nicaragua, improved sanitation has a rate of return of 7 times for each dollar invested (World Bank, 2013). Savings include a reduction in diarrheal disease, stunting of children's growth, and missed days of school or work.

Although rural populations overall are further from achieving universal access to WASH, Figures 5 to 8 show that from 2000 to 2017 the rate of improvement is much faster in rural areas relative to urban. This is likely because rural populations typically have less access to clean water, handwashing, and sanitation services, and governments therefore prioritize rural over urban areas as areas in greater need. Additionally, because rural populations are starting from dramatically less access there is much greater potential for rapid growth. However, as urban populations rapidly increase it is especially important for governments to take steps to sustainably plan urban city centers to ensure the urban poor has access to safe drinking water, sanitation services, and handwashing facilities. The United Nations predicts that by 2050 nearly 68% of the global population will live in urban areas; this is compared to the 55% that lived in urban areas in 2018 (United Nations DESA, 2019). This increase in urban population through migration paired with the minimal progress being made in urban areas to achieve SDG targets 6.1 and 6.2 highlights the need for development funding to be directed at urban areas as well.

There are many steps that developing urban areas can take to proactively prepare and plan cities to achieve SDG targets 6.1 and 6.2 in a cost-effective manner. It is typically more costly for governments to reactively build toilets or provide clean water services as the population increases, so it is important that urban areas take the necessary precautions now.

Steps urban areas can take to prepare differ based on many unique factors such as water availability, existing infrastructure, and budget; however, broadly applicable steps include improving wastewater reclamation through water recycling efforts or constructing water management systems (Rietveld et al., 2016). Local proactive planning has been shown to be a successful policy regarding urban sanitation efforts (Wellenstein, n.d.). This analysis shows that it is important to invest in both water and sanitation projects for the urban poor and rural populations.

Population Growth Stabilization as a Method to Improve Access to WASH

Population growth can be a large impediment to achieving universal access to WASH and therefore achieving SDG targets 6.1 and 6.2. Population growth is not the only impediment though, as limited funding, socio-economic levels, competing priorities, and many other factors also affect WASH. Therefore, stabilizing the population can have many auxiliary positive effects (Graff and Bremner, 2014). Graff and Bremner write, "Most leaders understand that development strategies depend on sustained investments in health care, education, employment, and natural resources. However, rapid population growth in many developing countries threatens to undermine these investments and exacerbate the challenges… It also puts pressure on agricultural land, fresh water, and energy resources" (Graff and Bremner, 2014). Family planning and other population stabilization efforts can help achieve SDG 6.1 and 6.2, meet the unmet desire that 220 million women have to regulate fertility, and save money due to the additional benefits from family planning efforts (e.g., escape poverty, increase family savings, and devote more time and resources per child) (Graff and Bremner, 2014). An effort to

acknowledge and work to improve family planning availability to stabilize the population can benefit access to WASH.

Conclusion

The SDG 6 Synthesis Report makes it clear that it is a priority that all regions across the world make continual progress towards achieving universal access to WASH, and that regions that are lagging in progress should have additional resources directed towards them (United Nations, 2018). By explicitly considering the diverse rates of population growth across the regions struggling to achieve SDG targets 6.1 and 6.2, this research provides additional context to what regions are not progressing at the necessary rates. It differentiates regions that may seem to be progressing towards WASH access at similar rates by using population growth rates as an additional explicit consideration; the extra context helps to understand the regions where population growth is having the largest negative impact on expanding access to WASH.

This research identified the importance of considering population growth rates when analyzing SDG 6.1 and 6.2 progress, especially for regions where population growth exceeds access to WASH (High concern in Table 8) or where the population grows at such a rate that the number of individuals without access is growing (Medium concern in Table 8). For these regions, it is important to focus development efforts toward limiting population growth in conjunction with increasing the rate of WASH growth. If the current rates continue, of the 18 regions analyzed, only four will achieve universal access in a single aspect of WASH by 2030; the remaining 14 regions will not achieve universal access in any aspect (High, Medium, and Low concern in Table 8).

References

Barnes, R., Ashbolt, N., Roser, D., & Brown, P. 2014. Implementing sustainable water and sanitation projects in rural, developing communities. *Waterlines*, *33*(1), 71–88.

CDC. 2018. "Products - Data Briefs - Number 297 - January 2018." https://www.cdc.gov/nchs/products/databriefs/db297.htm.

Family Planning 2020. 2020. "Data Hub." August 14, 2018. http://www.familyplanning2020.org/data-hub.

Graff, Maura, and Jason Bremner. 2014. "A Practical Guide to Population and Development," 24.

OCHA Services. 2014. "Papua New Guinea Battles Open Defecation - Papua New Guinea." Relief Web. Accessed December 13, 2020. https://reliefweb.int/report/papua-new-guinea/papua-new-guinea-battles-open-defecation.

Rietveld, L. C., J. G. Siri, I. Chakravarty, A. M. Arsénio, R. Biswas, and A. Chatterjee. 2016. "Improving Health in Cities through Systems Approaches for Urban Water Management." *Environmental Health* 15 (Suppl 1). https://doi.org/10.1186/s12940-016-0107-2.

Sinding, Steven W. 2009. "Population, Poverty and Economic Development." *Philosophical Transactions of the Royal Society B: Biological Sciences* 364 (1532): 3023. https://doi.org/10.1098/rstb.2009.0145.

Tumwine, James, John Thompson, Munguti Katui-Katua, Mark Mujwahuzi, Nick Johnstone, and Ina Porras. 2003. "Sanitation and Hygiene in Urban and Rural Households in East Africa." *International Journal of Environmental Health Research* 13 (2): 107–15. https://doi.org/10.1080/0960312031000098035.

UNESCO. 2015. "Rural Water Development." UNESCO. January 8, 2015. https://en.unesco.org/themes/water-security/hydrology/water-human-settlements/rural-development.

UNICEF. 2018. "2018 – 2020 Decentralized Urban Sustainable Sanitation Project Under the 2018 – 2022 UNICEF Country Program." https://upload.openaid.se/document/bolivia/12225_wash-unicef-project-document.pdf.

United Nations Department of Economic and Social Affairs (DESA). 2012. “Kenya .:. Sustainable Development Knowledge Platform.” https://sustainabledevelopment.un.org/memberstates/kenya.

United Nations, DESA, and Population Division. 2019. *World Urbanization Prospects: 2018 : Highlights*.

United Nations. 2015. “UN Projects World Population to Reach 8.5 Billion by 2030, Driven by Growth in Developing Countries.” *United Nations Sustainable Development* (blog). Accessed November 26, 2020. https://www.un.org/sustainabledevelopment/blog/2015/07/un-projects-world-population-to-reach-8-5-billion-by-2030-driven-by-growth-in-developing-countries/.

United Nations. 2016. “Resolution Adopted by the General Assembly on 17 December 2015 - 70/169. The Human Rights to Safe Drinking Water and Sanitation.” https://undocs.org/pdf?symbol=en/A/RES/70/169.

United Nations. 2018. “SDG 6 Synthesis Report 2018 on Water and Sanitation.” https://www.unwater.org/publications/highlights-sdg-6-synthesis-report-2018-on-water-and-sanitation-2/.

United Nations. 2019. “World Population Prospects - Population Division - United Nations.” 2019. https://population.un.org/wpp/.

United Nations. 2020. “SDG Indicator Database.” https://unstats.un.org/sdgs/indicators/database/.

United Nations. n.d. “UNSD — Methodology.” Accessed November 30, 2020b. https://unstats.un.org/unsd/methodology/m49/.

U.S. Census. 2020. “Population Clock.” https://www.census.gov/popclock/.

Wellenstein, Anna. n.d. “The Biggest Mistake of Cities Is Their Reactive Planning.” Habitat For Humanity. Accessed November 25, 2020. https://www.habitat.org/emea/stories/biggest-mistake-cities-their-reactive-planning.

WHO. 2018. “Millennium Development Goals (MDGs).” https://www.who.int/news-room/fact-sheets/detail/millennium-development-goals-(mdgs).

WHO/UNICEF JMP. n.d.a. “Drinking Water | JMP.” Accessed December 5, 2020a. https://washdata.org/monitoring/drinking-water.

WHO/UNICEF JMP. n.d.b. “Hygiene | JMP.” Accessed December 5, 2020b. https://washdata.org/monitoring/hygiene.

WHO/UNICEF JMP. n.d.c. “Open Defecation | JMP.” Accessed December 11, 2020c. https://washdata.org/monitoring/inequalities/open-defecation.

WHO/UNICEF JMP. n.d.d. “Sanitation | JMP.” Accessed December 5, 2020d. https://washdata.org/monitoring/sanitation.

World Bank. 2013. “Latin America and Caribbean: Economics of Sanitation Initiative | WSP.” 2013. https://www.wsp.org/content/latin-america-and-caribbean-economics-sanitation-initiative.

Zhang, Dandan, Xin Li, and Jinjun Xue. 2015. “Education Inequality between Rural and Urban Areas of the People’s Republic of China, Migrants’ Children Education, and Some Implications.” *Asian Development Review* 32 (1): 196–224. https://doi.org/10.1162/ADEV_a_00042.

Curriculum Vitae

Mackenzie Dalton Webber

Education

B.A. in Environmental Studies and Biology, Washington and Lee University. May 2018.

Capstone: Assessing the Removal of Jordan's Point Dam: Geomorphic, Ecological, and Recreational Impacts.

Professional Experience

Environmental Consultant at The Cadmus Group (July 2018 to Present).

Environmental Education Teacher at Boxerwood Nature Center (September 2015 to April 2018).

Research Interests

Water Quality and Security and International Development.